

# Global (North America, Europe, Asia-Pacific, South America, Middle East and Africa) Ferroelectric RAM Market 2018, Forecast to 2023

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## Abstracts

Ferroelectric RAM (FeRAM, F-RAM or FRAM) is a random-access memory similar in construction to DRAM but utilizing a ferroelectric layer instead of a dielectric layer to achieve non-volatility. FeRAM is one of a growing number of alternative non-volatile random-access memory technologies which can offer that same functionality as flash memory.

FeRAM consists of a grid of small capacitors and associated wiring and signaling transistors. Each storage element, a cell, consists of one capacitor and one transistor. Unlike the DRAM use a linear dielectric in its cell capacitor, dielectric structure in the FeRAM cell capacitor usually contains ferroelectric material, typically lead zirconate titanate (PZT).

A ferroelectric material has a nonlinear relationship between the applied electric field and the apparent stored charge. The ferroelectric characteristic has the form of a hysteresis loop, which is very similar in shape to the hysteresis loop of ferromagnetic materials. The dielectric constant of a ferroelectric is typically much higher than that of a linear dielectric because of the effects of semi-permanent electric dipoles formed in the crystal structure of the ferroelectric material. When an external electric field is applied across a dielectric, the dipoles tend to align themselves with the field direction, produced by small shifts in the positions of atoms and shifts in the distributions of electronic charge in the crystal structure. After the charge is removed, the dipoles retain their polarization state. Binary "0"s and "1"s are stored as one of two possible electric polarizations in each data storage cell. For example, in the figure a "1" is encoded using the negative remnant polarization "-Pr", and a "0" is encoded using the positive remnant polarization "+Pr". In terms of operation, FeRAM is similar to DRAM. Writing is

accomplished by applying a field across the ferroelectric layer by charging the plates on either side of it, forcing the atoms inside into the "up" or "down" orientation (depending on the polarity of the charge), thereby storing a "1" or "0". Reading, however, is somewhat different than in DRAM. The transistor forces the cell into a particular state, say "0". If the cell already held a "0", nothing will happen in the output lines. If the cell held a "1", the re-orientation of the atoms in the film will cause a brief pulse of current in the output as they push electrons out of the metal on the "down" side. The presence of this pulse means the cell held a "1". Since this process overwrites the cell, reading FeRAM is a destructive process, and requires the cell to be re-written if it was changed.

#### Scope of the Report:

This report focuses on the Ferroelectric RAM in global market, especially in North America, Europe and Asia-Pacific, South America, Middle East and Africa. This report categorizes the market based on manufacturers, regions, type and application. Ferroelectric RAM was proposed by MIT graduate student Dudley Allen Buck in his master's thesis, *Ferroelectrics for Digital Information Storage and Switching*, published in 1952. Development of FeRAM began in the late 1980s. Work was done in 1991 at NASA's Jet Propulsion Laboratory on improving methods of read out, including a novel method of non-destructive readout using pulses of UV radiation. Much of the current FeRAM technology was developed by Ramtron, a fabless semiconductor company. One major licensee is Fujitsu, who operates what is probably the largest semiconductor foundry production line with FeRAM capability. Since 1999 they have been using this line to produce standalone FeRAMs, as well as specialized chips (e.g. chips for smart cards) with embedded FeRAMs. Fujitsu produced devices for Ramtron until 2010. Since 2010 Ramtron's fabricators have been TI (Texas Instruments) and IBM. Since at least 2001 Texas Instruments has collaborated with Ramtron to develop FeRAM test chips in a modified 130 nm process. In the fall of 2005, Ramtron reported that they were evaluating prototype samples of an 8-megabit FeRAM manufactured using Texas Instruments' FeRAM process. Fujitsu and Seiko-Epson were in 2005 collaborating in the development of a 180 nm FeRAM process. In 2012 Ramtron was acquired by Cypress Semiconductor. FeRAM research projects have also been reported at Samsung, Matsushita, Oki, Toshiba, Infineon, Hynix, Symetrix, Cambridge University, University of Toronto, and the Interuniversity Microelectronics Centre (IMEC, Belgium).

The worldwide market for Ferroelectric RAM is expected to grow at a CAGR of roughly 3.7% over the next five years, will reach 300 million US\$ in 2023, from 240 million US\$ in 2017, according to a new GIR (Global Info Research) study.

Market Segment by Manufacturers, this report covers

Cypress Semiconductor

Fujitsu

Texas Instruments

IBM

Infineon

Market Segment by Regions, regional analysis covers

North America (United States, Canada and Mexico)

Europe (Germany, France, UK, Russia and Italy)

Asia-Pacific (China, Japan, Korea, India and Southeast Asia)

South America (Brazil, Argentina, Colombia etc.)

Middle East and Africa (Saudi Arabia, UAE, Egypt, Nigeria and South Africa)

Market Segment by Type, covers

Serial Memory

Parallel Memory

Others

Market Segment by Applications, can be divided into

Smart Meters

Automotive Electronics

Medical Devices

Wearable Devices

There are 15 Chapters to deeply display the global Ferroelectric RAM market.

Chapter 1, to describe Ferroelectric RAM Introduction, product scope, market overview, market opportunities, market risk, market driving force;

Chapter 2, to analyze the top manufacturers of Ferroelectric RAM, with sales, revenue, and price of Ferroelectric RAM, in 2016 and 2017;

Chapter 3, to display the competitive situation among the top manufacturers, with sales, revenue and market share in 2016 and 2017;

Chapter 4, to show the global market by regions, with sales, revenue and market share of Ferroelectric RAM, for each region, from 2013 to 2018;

Chapter 5, 6, 7, 8 and 9, to analyze the market by countries, by type, by application and by manufacturers, with sales, revenue and market share by key countries in these regions;

Chapter 10 and 11, to show the market by type and application, with sales market share and growth rate by type, application, from 2013 to 2018;

Chapter 12, Ferroelectric RAM market forecast, by regions, type and application, with sales and revenue, from 2018 to 2023;

Chapter 13, 14 and 15, to describe Ferroelectric RAM sales channel, distributors, traders, dealers, Research Findings and Conclusion, appendix and data source

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